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LAMONT GEOLOGICAL OBSERVATORY
Columbia University
Palisades, New York

Semi-annual Technical Summary Report
January 1, 1964 - June 30, 1964

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Studies in marine geophysics and underwater
sound from drifting ice stations.

I. Field Operations at T-3

The research program at T-3 during the winter and spring continued with depth gravity, and magnetic measurements. Navigation and weather data were also taken as necessary background for the geophysical observations.

The station was over the Alpha Rise from Jan. 1 to Jan. 12. The Precision Depth Recorder was out of order from Jan. 12 to Jan. 24. When it was repaired, the station was found to be over the Canada Abyssal Plain at a depth of about 3760 m. Beginning in April the abyssal plain became slightly shallower. By the end of May, depths were about 3740 m. The ice island was proceeding in an easterly direction toward the Canadian Archipelago during these months. The past year's drift has clarified considerably our knowledge of the Alpha Rise and Canada Abyssal Plain topography.

Continuous recordings of the total magnetic field were made. Some trouble was encountered with magnetometer during late spring but repairs were successfully made and it continues in operation.

The gravity meter has been trouble-free. The meter was returned to Barrow for a gravity tie at the pendulum station in June. The meter continues to show almost negligible drift between ties to Barrow.

Celestial navigation is used for positioning the island. Fixes were taken daily when weather conditions permitted.

Surface weather observations were taken three times daily and radioed to Barrow for transmission onto the WMO net.

A vertical long-period seismograph continued in operation throughout the winter. The purpose is to collect information on earthquakes and wave motion in the Arctic Ocean. The great Alaskan earthquake in March was recorded but the amplifiers were overloaded for much of the wave train. The background level of surface noise is one of the interesting results of this experiment. The background noise, which may be considered as the wave motion on the Arctic Ocean, is much higher in the winter than in the summer. It is believed that this may be correlated with winter storms in the North Atlantic which produce long-period waves which travel into the Arctic Ocean.

Several bottom photograph stations were taken on the Canada Abyssal Plain. These photographs show the rather rough, burrowed surface which we have come to associate with the abyssal plain. The Alpha Rise, in contrast, has a smooth, gentle topography in the bottom photographs taken there last summer.

During the coming summer, further hydrographic stations are planned to supplement those taken last summer. Further large-volume water samples will also be taken for radiochemical analysis.

II. Data analysis at Lamont

1. Marine Geophysics Special efforts have been made during this period to accelerate the reduction of large amounts of data collected on T-3 over the past two years. Additional personnel have been hired to assist with the reduction of navigation, gravity, magnetic and depth data. The effort has been largely successful and several papers have been completed or are in preparation on aspects of the marine geophysics.

The data collected in 1962 over the Chukchi Cap has been completely analyzed and incorporated into a paper. The paper, "Arctic Ocean Geophysical Studies: Chukchi Cap and Chukchi Abyssal Plain" by Shaver and Hunkins has been accepted for publication by Deep-Sea Research and it is now in press. An abstract of that paper follows:

"A bathymetric chart of the Chukchi Cap region was compiled with soundings obtained from Fletcher's Ice Island (T-3), as well as from other ice stations and from U. S. Navy icebreakers. New details of the Chukchi Cap are shown, including two submarine troughs on the southwest side. West of the Chukchi Cap, a small abyssal plain was found with a depth of 2230 m.

This abyssal plain is connected through an abyssal gap with the deeper Canada Abyssal Plain.

The prominent magnetic anomaly discovered during the drift of Station Charlie was crossed more recently by T-3 and by aeromagnetic flights. The continuity of the anomaly along the western and northern sides of the Chukchi Cap was further established by the new measurements. An interpretation was made of the anomaly as an expression of induced magnetization in basement rocks. The interpretation shows a basement ridge beneath the anomaly maximum at the edge of the Chukchi Cap. The cap itself is interpreted as being underlain by a 12 km thickness of sediments. Both magnetic and gravity data were used for an interpretation of total crustal thickness along the same section. Crustal thickness ranges from 18-1/2 km beneath the Chukchi Cap to 32 km beneath the large basement ridge."

The data collected from T-3 during 1963 over the Alpha Ridge and Canada Abyssal Plain have been reduced and a paper is planned on "Arctic Ocean Geophysical Studies: Alpha Ridge and Canada Abyssal Plain". Precision Depth Recorder data is available over most of the track and a bathymetric chart is being drawn from it. Gravity and magnetic data will also be incorporated into the study.

Results from the drift of Arlis II during 1962 have been studied by Henry Kutschale. He has completed a paper titled, "Arctic Ocean Geophysical Studies: the Southern Half of the Siberia Basin" which will be submitted soon for publication. The work will constitute his doctoral dissertation. An abstract of the paper follows:

"In 1962 ice island Arlis II drifted over a portion of the southern half of the Siberia Basin. Depth recordings made between 81°N, 170°E and 82°30'N, 160°E show that the ocean floor in this area is an abyssal plain (depth about 2825 m) dissected by several interplain channels. The name Wrangel Abyssal Plain is proposed for this feature. Wrangel Abyssal Plain is bounded on the north by Arlis Gap which joins Wrangel Abyssal and Siberia Abyssal Plain (depth about 3950 m). Siberia Abyssal Plain occupies the northern half of the Siberia Basin. Seismic profiler recordings show that a prominent sub-bottom basement ridge exists in the vicinity of Arlis Gap. This ridge strikes in an approximately northwest direction and appears to connect with Alpha Ridge, which bounds the Siberia Basin on the east and north, and Lomonosov Ridge, which bounds the Siberia Basin on the west. The seismic profiler measurements also show that at least 3.5 km of nearly horizontally stratified sediments underlie Wrangel Abyssal Plain south of the ridge. Each layer within these sediments appears to correspond to the fossil surface of Wrangel Abyssal Plain. This thick sequence of stratified sediments shows the influence of the Asian continent, which bounds the Siberia Basin on the south, on sedimentation within the Siberia Basin. Presumably the buried basement ridge forms a dam which permitted the accumulation of a thick sequence of sediments under the higher-level Wrangel Abyssal Plain. Turbidity currents moving through Arlis Gap presumably carried the overflow of sediments from Wrangel Abyssal Plain into the lower-level Siberia Abyssal Plain. The structure of the sediments suggests that the Siberia

Basin has been free from deformation, except possibly for broad crustal warping, during the deposition of the sediments. A crustal model based on the water depth measurements, profiler measurements, gravity measurements and magnetic measurements yields a crustal thickness of 15km south of the buried ridge and 23km under the ridge. All present geophysical measurements indicate that the sediments within the Siberia Basin overlie a crust similar to that found in other ocean basins of the world."

2. Underwater acoustics

SOFAR sound propagation. Experimental group-velocity dispersion curves have been obtained for waves corresponding to nine normal modes. Measured amplitudes of vibration as a function of wave frequency, shot depth, and detector depth have been plotted for the first normal mode. The effects of changing bathymetry along the propagation path of the SOFAR signal was studied in detail. Preliminary measurements were made of the effects of the source spectrum on the excitation of the normal modes and the reverberation following the main part of the SOFAR signal. Excellent agreement has been obtained between the measured group-velocity dispersion curves and the corresponding dispersion curves calculated for a model representing the SOFAR channel.

Ambient noise. Ice vibration data obtained aboard ARLIS II in May 1962 has been analyzed in detail. Analysis was done with band-pass filter techniques.

A mapping project of the Antarctic Sofar channel was begun this year. The experience gained by the group with Sofar propagation in the Arctic Ocean led to interest in Antarctic sof ar propagation. The depth of the channel axis as a function of geographic position is being studied. It is planned that a map of the sof ar channel depths in the Antarctic Ocean will be made. This map will be incorporated into the Oceanographic folio of the Antarctic Map Series which will be published by the American Geographical Society.

3. Physical Oceanography

The hydrographic station data collected during 1963 have been reduced by John Yearsley at Woods Hole. It is intended to present these data in the form of a technical report in the near future.

Radiocarbon measurements on the large-volume water samples taken in 1963 have been completed. The results indicate the rapid transport in the Atlantic layer which has been inferred from other evidence. More samples will be taken this summer in order to better specify the rate of transport.

Current meter data collected last year has been reduced and is now being analyzed. Power spectral analyses are being made in an effort to determine the relative importance of inertial and tidal motion. The records were sampled once per hour for this purpose. More frequent sampling is planned in order to obtain information on shorter period motion and its variation with depth.

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